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ENVIRONMENTAL QUALITY AND OCCUPATIONAL HEALTH SPECIAL EMPHASIS AREA PLAN (SEAP)

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Human Systems Division
Air Force Systems Command
Brooks Air Force Base, TX 78235-5000

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This report has been reviewed and is approved for publication.

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19. ABSTRACT (Continue on reverse if necessary and identify by block number)

The Deputy for Development Planning, Human Systems Division, is tasked with performing studies and analyses to identify future requirements in the areas of crew protection and aerospace medicine, crew system integration, force readiness, and environmental protection. This Special Emphasis Area Plan (SEAP) focuses on the functional area of environmental protection, identifying systems and enabling technologies needed to support the goals of Air Force environmental programs. This SEAP also lists Air Force Systems Command programs related to these systems and technologies and assesses the time frame and criticality of each technology relative to the system it supports. Systems discussed include hazardous material identification and toxicity evaluation systems, cost modeling systems, improved industrial hygiene and waste minimization systems, environmental monitoring technology evaluation systems, and simulation and testing facilities, risk analysis and cost projection systems, and long term environmental planning systems. Enabling technologies include biologically based toxicity computer modeling, rapid toxicity screening, tiered approach to toxicity testing, artificially intelligent expert (Cont'd)

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ENVIRONMENTAL QUALITY
AND
OCCUPATIONAL HEALTH SPECIAL EMPHASIS AREA PLAN

I. INTRODUCTION

The Deputy for Development Planning, Human Systems Division, is tasked to perform studies and analyses identifying future requirements in the areas of crew protection and aerospace medicine, crew system integration, force readiness, and environmental protection. This Special Emphasis Area Plan (SEAP) focuses on the functional area of environmental protection. This functional area is concerned with protection of the environment from the stresses caused by military operations and with the protection of humans from the potentially hazardous nature of some workplace environments. These two areas are commonly called Environmental Quality and Occupational Health. The purpose of this SEAP is to:

1. Identify general areas of research, development, and acquisition needed to support the goals of Air Force environmental programs.

2. Describe the systems needed to accomplish stated goals.

3. Identify the specific enabling technologies which must be developed to build these systems.

4. Identify the related AFSC programs which contribute to the development of these technologies.

5. Assess when the enabling technology is needed relative to the development of the system it supports.

6. Assess the criticality of each enabling technology with respect to its contribution to the building of the system it supports.

The intention of this document is to establish a requirements baseline for research, development, and acquisition in the environmental protection functional area. Although every attempt was made to systematically identify future needs, there is no assurance that all of the significant issues have been included, or that all of the enabling technologies have been elucidated. Changes in USAF missions, future studies, analyses, and other factors may add to or subtract from the identified requirements.

The purposes of this document are to provide guidance for investment strategy decisions and to stimulate thought. One of the principal utilities of this document will be to establish a framework within which existing programs, new starts, independent studies, and Small Business Innovative Research efforts can be grouped. Thus, it will be ensured that developed technologies and processes contribute to the overall goals of USAF environmental quality programs in a coordinated and organized manner.

II. METHODOLOGY

A. The role of the human is an integral and important aspect in planning and designing of future weapon systems. To ensure that this role is not ignored, the Human Systems Division Deputy for Development Planning has initiated a systematic human-centered requrements review of each of the eleven United States Air Force (USAF) mission areas. In this requirements review a standardized analysis methodology is applied to identify potential human related problems which could result from future missions, threats, operations concepts, and capabilities of Air Force weapons systems. These systems requirements are documented in the Requirements Identification and Technology Assessment Summaries (RIATAS), which are made available to planners within Air Force Systems Command, in other operational Major Air Commands, and in the research and development community.

B. While the RIATAS analyses address broad human-centered systems requirements by mission area, the Special Emphasis Area Plans (SEAP) group common requirements into functional areas. Further, the SEAPs decompose the systems requirements into contributing enabling technologies. In short, a SEAP is a concise summary of needed technologies in a single functional area, which can be used to assist planning for systems development in support of future USAF capabilities.

C. The systems requirements documented in this Environmental Quality and Occupational Health SEAP stem from requirements listed in the RIATAS studies and also from the results of special studies carried out by other USAF organizations. Enabling technolgies were identified from ongoing programs, from specific findings of other special studies, and from analytical review of the systems requirements.

D. In the discussion of each enabling technology, the related research, development, and acquisition programs are presented. A program is related to the enabling technology if:

1. The program is currently developing the specific enabling technology listed,

2. The program is developing technology which could be applied to the area discussed, or

3. A new start technology development effort in the area of the enabling technology would possibly fall within the purview of the program.

E. The assessment section for each enabling technology provides an estimate of two factors as they apply to that specific technology and the capability need driving the requirement. The asessments were made subjectively by the analyst, based upon knowledge derived during the analysis and the inputs provided by the using commands. The following factors were evaluated:

1. Timeliness. Timeliness refers to the target date when the technology is required to support the desired operational capabilities. The following terms are used:

a. Near-Term - Present to 5 years
b. Midterm - 5 years to 15 years
c. Far-Term - Beyond 15 years

2. Criticality. This factor refers to the degree to which the desired capabilities depend on the technology identified. The following ratings apply:

a. High - The capability cannot be achieved without substantial advances in the identified technology.

b. Medium - Substantial negative operational impacts can be expected if significant advances are not made in the identified technology.

c. Low - Advancements in the technology would improve the efficiency or effectiveness of the operational capability.

III. SUMMARY OF REQUIREMENTS AND ENABLING TECHNOLOGIES

A. Desired Capability: Integration of Hazardous Materials Considerations into the Weapon System Acquisition Process.

One of the primary considerations in weapon systems acquisition is the affordability of the system throughout its life cycle. Initial procurement of the basic system is only part of this total cost, and is usually the best understood cost area. The costs of operations and maintenance, modifications, manpower, personnel, training, and safety all contribute significantly to the total system cost. Under the general area of safety, life cycle costs of weapons systems must include the resources associated with the use of hazardous materials in the systems. Costs associated with the storage, transportation, use, and disposal of hazardous consumables and supplies needed to maintain the system are substantial, and possibly avoidable to some degree by appropriate up front planning.

The engineering design of the system and the operational concept in which the system is used are the primary determining factors in the types of consumables and supplies needed. For example, the F-16 is equipped with an emergency power unit which provides electrical power for flight control when main engine power is interrupted. This subsystem is fueled by hydrazine. Servicing the emergency power unit involves special procedures for the transfer, storage, and disposal of this hydrazine, and adds man-hours to the baseline maintenance of the F-16 system as a whole. The life cycle cost of the F-16 fleet could have been possibly reduced substantially had this system been engineered to use a less toxic fuel.

Department of Defense guidelines for hazardous material management indicate that management of such materials should incur the lowest life-cycle costs consistent with protecting human health and the environment. Complying with these guidelines will require advances in two major technical areas (see Fig. 1). First, of the multitude of materials available for use in future weapon systems, the nature of the toxicity of hazardous materials must be evaluated. Computer-based toxicological models must be developed to the extent that information about a particular compound or substance can be obtained without having to proceed with lengthy animal toxicology studies. Next, a mechanism must be created whereby decisions involving engineering options consider the toxicological properties of materials in addition to other physical properties. Tools which can predict the added cost in hazardous materials handling, storage, and general environmental protection must be designed and integrated into the system life-cycle cost projection system. These advances could provide the scientific and engineering basis for responsible decisions regarding materials used in future weapon systems. Figure 1 summarizes the relationship of these needed development efforts.

1. System Requirement: Hazardous Material Identification and Toxicity Evaluation System

Improved fuels, hydraulic fluids, lubricants, sealants, coatings, and structural materials are continually being developed not only for use in future aircraft, but

also to replace those currently used in deployed aircraft and missile systems. What is needed is a means to (1) define human tolerance limits to chemicals/materials proposed for new USAF systems, (2) to conduct material hazard assessments prior to weapon acquisition, and (3) to develop a computer-intelligent hazardous material identification system for assessing new and existing compounds. The key to this capability is further refining toxicology standards and to initiating work on an expert system which will use these standards and other information for hazardous materials assessment and evaluation. Figure 2 breaks down this system for identification and evaluation of hazardous materials into its component enabling technologies, which are summarized below.

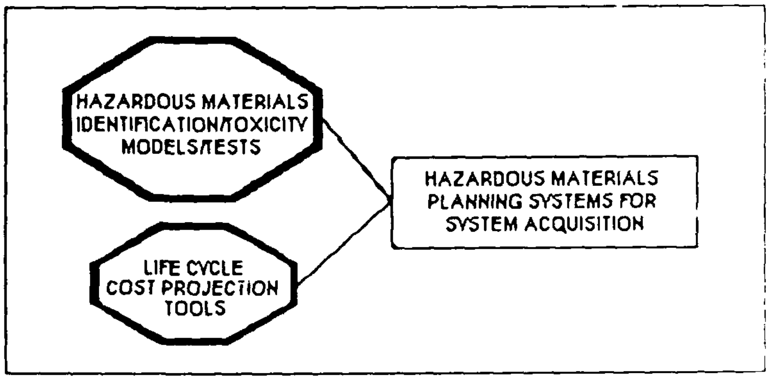

Figure 1

a. Enabling Technology: Biologically-based Toxicity Computer Modeling

(1) Discussion: Further development and refinement of Biologically-based Toxicity Computer Modeling (BTCM) are necessary to improve the quantitative extrapolation of animal studies for the human risk assessment of new materials.

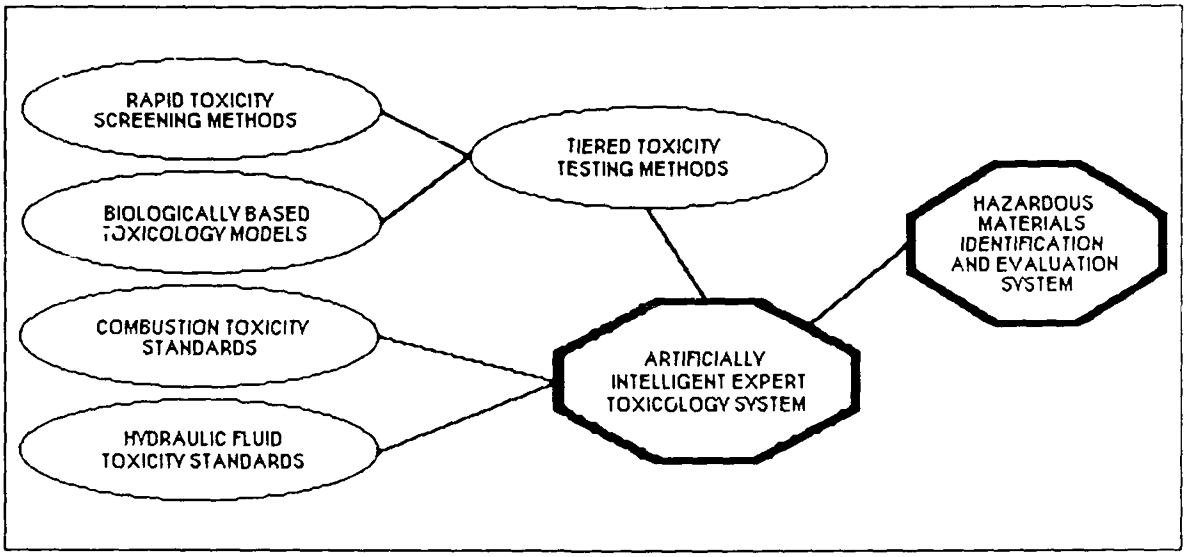

Figure 2

It is necessary to incorporate BTCM into present toxicity studies, not only to improve the experimental design of the study, but also to aid in the realistic interpretation of the results. The use of BTCM in toxicity studies will result in the more efficient use of research resources and will ultimately decrease the number of animals needed for conducting toxicology studies. Most importantly, the use of BTCM will greatly enhance quantitative analysis of the life cycle cost implications of hazardous material applications.

(2) Related Program:

PE/Proj	Title
62202F	Aerospace Biotechnology
Proj 6302	Operational and Environmental Toxic Hazards in Air Force Operations

(3) Assessment:

Timeliness - Near   Criticality - Medium

b. Rapid Toxicity Screening

(1) Discussion: A rapid screen for potential toxicity is necessary to provide timely information to the decision process for choosing a new chemical or material during the early design phase of weapon systems development. A series of in vitro toxicity and metabolism assays coupled with modeling analysis could quickly assess of the potential toxicity of a material early in the acquisition process.

(2) Related Program:

PE/Proj	Title
62202F	Aerospace Biotechnology
Proj 6302	Operational and Environmental Toxic Hazards in Air Force Operations

(3) Assessment:

Timeliness - Near   Criticality - Medium

c. Tiered Approach to Toxicity Testing

(1) Discussion: In the development of a given weapon system, the basic airframe, subsystem, or missile design evolves from numerous possibilities in the concept development phase to a "frozen" design at full scale development. This narrowing of design options is achieved as the different engineering proposals, studies, and tradeoffs are made. The level of detail of the information that engineers need to perform these trade-offs increases as the design matures. In-depth toxicological data may not be needed for every proposed material considered in the early phases, but it may be necessary for decisions later in the program. In a tiered approach to toxicity testing, a valid decision tree would be used to determine the level of toxicity information necessary at different stages of the development process. This approach would provide the appropriate level of testing as candidate materials are proposed by USAF laboratories, resulting in substantial cost and time savings.

(2) Related Program:

PE/Proj	Title
62202F	Aerospace Biotechnology
Proj 6302	Operational and Environmental Toxic Hazards in Air Force Operations

(3) Assessment:

Timeliness - Near Criticality - Low

d. Artificially Intelligent Expert Toxicology System

(1) Discussion: There is a need to develop a knowledge base for existing toxicity data. An expert system which can predict the toxicity of new chemicals based on existing data can be developed using an inference engine program which incorporates structure activity relationships (SAR) data into the knowledge base.

(2) Related Program:

PE/Proj	Title
62202F	Aerospace Biotechnology
Proj 6302	Operational and Environmental Toxic Hazards in Air Force Operations

(3) Assessment:

Timeliness - Near Criticality - High

e. Combustion Toxicology Standards

(1) Discussion: There is a need for the development of improved, reproducible techniques for accurately evaluating the toxicity of pyrolysis and/or combustion products of USAF materials. A combustion toxicology program should (1) employ BTCM to interpret results of USAF combustion toxicology studies, (2) incorporate behavioral responses into experiments, and (3) analyze combustion gases.

(2) Related Program:

PE/Proj	Title
62202F	Aerospace Biotechnology
Proj 6302	Operational and Environmental Toxic Hazards in Air Force Operations

(3) Assessment:

Timeliness - Near Criticality - Medium

f. Hydraulic Fluids Toxicology Studies

(1) Discussion: A major toxicology program is being developed to assess the potential toxicity of a candidate nonflammable hydraulic fluid for future aircraft systems. As part of the program, a study of alternative formulations of hydraulic fluids will be conducted; information from the study will be used to build a toxicity data base with which to compare candidate fluids. Continuation and extension of this project to include new synthetic materials is needed to assess future candidate hydraulic fluids.

(2) Related Program:

PE/Proj	Title
62202F	Aerospace Biotechnology
Proj 6302	Operational and Environmental Toxic Hazards in Air Force Operations

(3) Assessment:

Timeliness - Near Criticality - Medium

2. System Requirement: Hazardous Material Standards and Cost Modeling to Support Weapon System Acquisition

To make intelligent choices between alternate materials for a given application, it will be necessary to accumulate more information about each individual material than is currently available. Advantages of one material in simple physical properties such as viscosity, density, strength, and resistance, may be outweighed by its toxic nature or by its resistance to standard disposal methods. It is therefore necessary to develop measures of these "soft" properties which can be used with hard physical properties to directly compare different materials in initial systems design stages. To better calculate the impact on operational costs of using a given material, it is necessary to develop tools which can project future costs associated with handling and disposing the material. These cost projection tools, combined with engineering properties, would provide the type of information that can be easily factored into the design process. The enabling technologies comprising such a system are summarized in Fig. 3 and below.

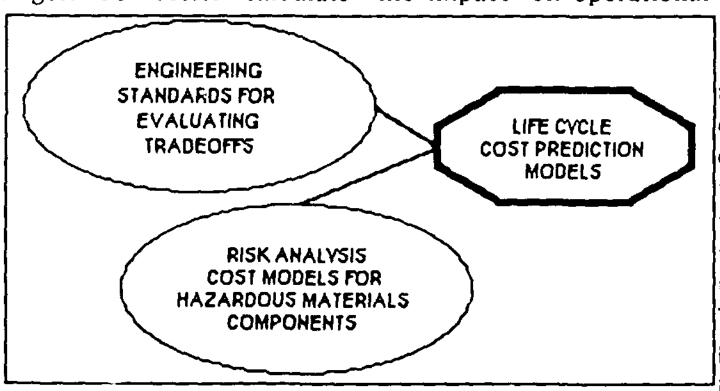

Figure 3

a. Enabling Technology: Standards for Evaluating Engineering Trade-offs.

(1) Discussion: Metrics for quantifying intangible risk factors are needed to enable the direct comparison of materials when engineering options are decided in weapons system design and development. Measures of merit and other tools are needed which can evaluate cost savings and performance versus risk in terms of public concern and potential for long term environmental and human health degradation.

(2) Related Programs - None

(3) Assessment:

Timeliness - Midterm Criticality - Medium

b. Cost models

(1) Discussion. To support life cycle cost determinations, methods are needed for estimating the projected cost of using a particular hazardous material over the life of the system. These estimates must include the costs of manufacture, supply, use, storage, recycling, emission control, work place safety, medical monitoring, regulatory overhead, disposal, and liability. Advanced algorithms are needed which can project costs into the future, taking into account increased regulation and the possible effects of pre-planned product improvements.

(2) Related Programs - None

(3) Assessment:

Timeliness - Near Criticality - High

B. Desired Capability: More Effective Environmental Quality and Industrial Hygiene Operations

The USAF carries out large scale industrial processes at the five air logistics centers and in maintenance activities at individual bases. Engine repair, corrosion control, airframe overhaul, electronics maintenance, and associated activities employ thousands of civilian and military workers. Large quantities of materials of all kinds are used, from cement, rubber, steel, and aluminum to solvents, cleaners, inspection fluids, oils, paints, corrosives, adhesives, and abrasives. Managing the storage, transfer, use, and disposal of large quantities of hazardous and toxic materials is a challenge for environmental quality specialists. Maintaining healthy workplaces for employees, many of whom spend their entire working career in this environment, is a challenge for industrial hygienists and occupational health professionals.

Because of the trend toward increased levels of environmental quality and workplace environment regulation, these environmental coordinators and occupational health specialists will be faced not only with overseeing tighter controls on materials, but also with requirements to monitor workplace atmosphere more frequently,

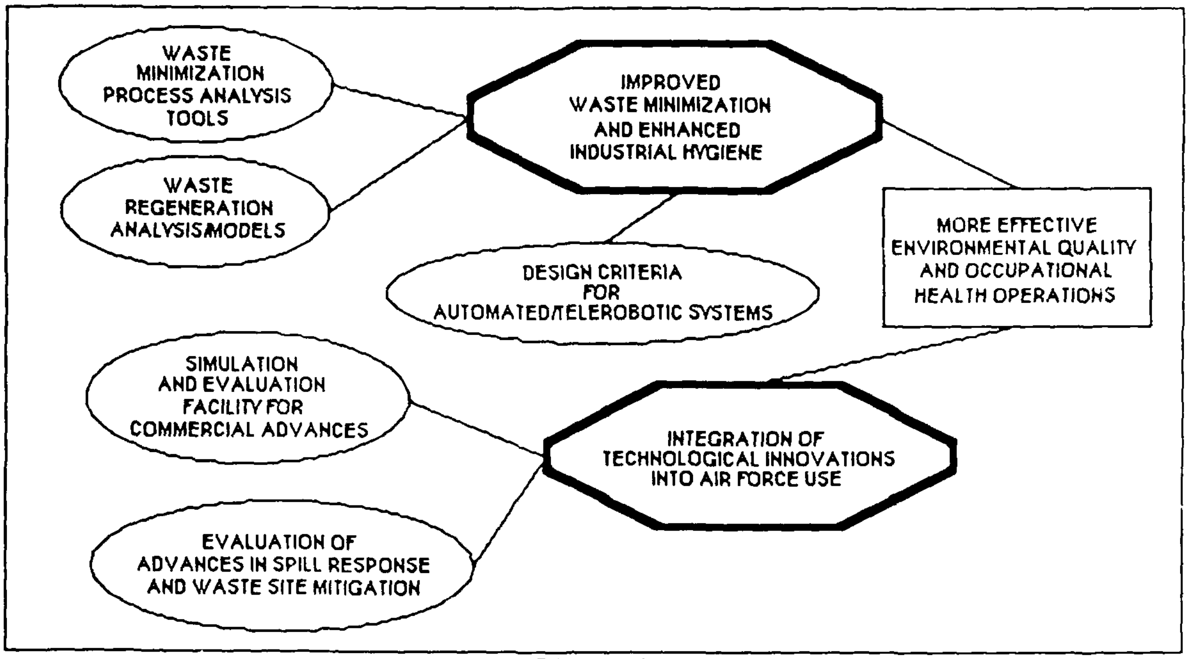

Figure 4

using tighter controls at lower contaminant levels. Laboratory workload will steadily increase as a result of this higher demand, and costs per analysis will rise abruptly as higher precision laboratory equipment is required for lower level detection. By minimizing waste and regenerating materials, the USAF can decrease the total amount of material to manage. Use of direct reading instruments and other on-site monitoring devices can simplify industrial hygiene operations and decrease laboratory workload. Opportunities exist in both these areas to exploit commercially available technologies to the benefit of environmental quality and occupational health services. The required systems and supporting technologies are presented in Fig. 4 and summarized below.

1. System Requirement: Improved Industrial Hygiene and Waste Minimization System

The same general technology advancement which gives rise to the increased use of diverse synthetic and potentially hazardous materials in weapons systems also yields more advanced industrial processing techniques. In some cases, advanced processes can use more benign materials as substitutes for hazardous operations. For example, a new technique for stripping paint from aircraft uses a mixture of sodium bicarbonate and water at high pressure. If successful, this process will replace the previous chemical stripping technique, which used a mixture of phenol and methylene chloride. These techniques can be used to more efficiently process material; they minimize waste, using materials is such a way that they can be regenerated or recycled, or they replace humans in particularly hazardous operations.

a. Enabling Technology: Methods for Analyzing Industrial Processes to Identify Opportunities for Waste Minimization

(1) Discussion: Research methods are needed for evaluating industrial processes to identify waste minimization opportunities. Tools for designing and assessing advanced processing techniques are also needed to maximize technological leverage in this area.

(2) Related Programs

PE/Proj	Title
63723F	Civil Engineering and Environmental Quality Technology
Proj 2103	Environmental Quality Technology

(3) Assessment

Timeliness - Near Criticality - Medium

b. Methods for Identifying Waste Regeneration Opportunities

(1) Discussion. Regeneration and recycling may provide a cost effective alternative to disposal for some materials in large scale use. Methods for designing and evaluating regeneration and recycling processes are needed to establish these systems where practical.

(2) Related Programs

PE/Proj	Title
63723F	Civil Engineering and Environmental Quality Technology
Proj 2103	Environmental Quality Technology

(3) Assessment

Timeliness - Near Criticality - Medium

c. Design Criteria for Advanced Materials Processing and Handling Systems

(1) Discussion: Requirements for high performance in future weapons systems will necessitate the use of high activity or exotic fuels and consumables in certain applications. New concepts in storing, handling, and processing these types of materials will be needed to safeguard the health of workers and minimize the potential for spills or other incidents. Designs for automated or telerobotic systems must be developed with the human operator in mind. Human-machine interface design tools are needed to blend the abilities of the operator and the system.

(2) Related Programs - None

(3) Assessment:

Timeliness - Mid Criticality - Medium

2. System Requirement: Technology Evaluation System

Landmark legislation such as the Clean Water Act, the Clean Air Act, the Occupational Safety and Health Act, and the Resource Conservation and Recovery Act, along with subsequent regulatory agency oversight, has focused attention on maintaining the quality of the environment and workplace. Government and industry are both subject to the individual requirements for waste disposal, wastewater sampling and treatment, and industrial hygiene air sampling surveys, set forth in the regulations dealing with occupational health and environmental quality.

This requirement for regulatory compliance on such a large scale has led to the growth of an industrial hygiene and environmental services industry. Small firms and research laboratories have introduced innovative approaches to accomplishing many traditional sampling and analysis tasks by developing specialized direct reading instruments, field testing equipment, multi-function sensor probes, and solid phase extraction devices. Many industrial plants have realized substantial cost savings through the use of these easy-to-use, low maintenance items.

Since there is much commonality between USAF and civilian industrial operations, opportunities exist for following industry's lead in exploiting these cost-effective innovations and transferring them to the USAF environment. What is needed is a dedicated center for the evaluation of these types of technical breakthroughs for their operational suitability.

a. Enabling Technology: Simulation and Testing Facilities for Evaluating Sampling Technology Advances.

(1) Discussion: Establishment of a central facility is needed for testing and evaluating new environmental monitoring and industrial hygiene support equipment for USAF use. This facility would require the latest in vapor generation and gas dilution systems for realistic simulation, testing, and evaluation of simplified air sampling methods, media, and direct-reading instruments. The facility should have realistic simulation capability for evaluating transportable or portable gas chromatography/mass spectrometry systems for on-site hydrocarbon analysis.

(2) Related Programs:

PE/Proj	Title
63723F	Civil Engineering and Environmental Quality Technology
Proj 2103	Environmental Quality Technology

(3) Assessment:

Timeliness - Near Criticality: Medium

b. Evaluation Methods, Systems, and Facilities for Assessing Innovations in Hazardous Materials Spill and Waste Site Mitigation

(1) Discussion: Because of strong regulatory and public pressure, hazardous waste site cleanup has become a widespread concern. Industrial waste sites as well as those owned by federal and state agencies are subject to EPA cleanup mandates. Therefore, there are compelling commercial interests in developing technologies for cutting the costs of waste site mitigation. It is necessary to evaluate these commercially available technologies and approaches to determine the most appropriate for USAF applications. There is the potential for high payoffs in materials, methods, and procedures for spill response to minimize future environmental contamination. Also needed are studies focusing on new technologies in waste site restoration, including advanced evaluation methods and in situ biological cleanup.

(2) Related Program:

PE/Proj	Title
62202F	Aerospace Biotechnology
Proj 6302	Operational and Environmental Toxic Hazards in Air Force Operations
63723F	Civil Engineering and Environmental Quality Technology
Proj 2103	Environmental Quality Technology

(3) Assessment:

Timeliness - Near Criticality - Medium

C. Desired Capability: Long Term Environmental Planning

Many of the environmental quality problems currently under study resulted from past practices which were not recognized as potential sources of environmental stress at the time. Only when modern toxicological methods were developed were these stresses identified. For example, polychlorinated biphenyls (PCBs) were used as dielectric fluids for decades because of their thermodynamic stability and insulating properties. Thousands of tons of PCBs were routinely disposed of in landfills in the same fashion as used oil. In the 1960s and 1970s, modern analysis methods discovered the potential carcinogenicity of PCBs, as well as PCBs' resistance to breaking down even after years in the environment. Similarly, because of the lack of appropriate guidelines for the safe storage and disposal of hazardous wastes in the past, these wastes were sometimes managed in a haphazard and careless manner. The leaching of these substances through the subsurface into drinking water supplies was not identified until relatively recently, when environmental quality state-of-the-art matured.

In response to the identification of environmental quality problems, governmental agencies issue regulations to correct these situations, and federal, state, municipal, and industrial entities are required to enact corrective actions within a time limit specified in the regulatory action. Organizations perform surveys to determine the extent of the problem, acquire laboratory and consulting expertise, initiate measures to control the source of the problem, and establish long term monitoring to ensure the problem was indeed controlled. These compliance actions are typically very expensive in terms of resources, manpower, and time. In many cases, the entire problem could have been avoided had foreknowlege of the potential health risks of substances been available.

As discussed earlier, hazardous materials considerations must be integrated into the weapons systems acquisition process to allow smart decisions today which can reduce life cycle costs. In the same vein, a long-term planning outlook founded on sound environmental policy is needed in the areas of civil engineering and installation of capital improvements to prevent environmental problems in the future. This proactive approach should encompass plans for all aspects of the USAF infrastructure, including building construction, specialized mission support such as fuel storage, and normal operations such as utilities distribution, pest control, and waste disposal. The building blocks for such a system are presented in Figure 5 and are summarized below.

1 System Requirement: Comprehensive Risk Analysis and Cost Projection System

Installation improvements and construction projects designed in consonance with sound environmental policies should not only be ecologically benign, but also create a healthy work environment for employees. For example, many energy efficient buildings were constructed so that there is little or no atmospheric exchange with outside air. These "tight" buildings are actually unhealthy for workers because indoor air pollutants --formaldehyde from carpets, volatile hydrocarbons from photocopier chemicals, radon, and bacteriological agents are constantly recirculated throughout the structure. The risk of potential problems with worker health, as well as with adverse environmental impacts must be carefully weighed during the design process.

These risks must be minimized wherever possible. An analysis system is needed which can provide solid cost estimations of candidate solutions.

a. Enabling Technology:Risk Analysis Methods for Evaluating Construction and Capital Improvement Alternatives

(1) Discussion: Detailed analysis methods are needed for identifying potential environmental risks associated with future construction plans and capital improvement concepts. Areas of risk could include concerns with indoor air pollution, susceptibility to radon intrusion, emissions of volatile fuel vapors into the atmosphere, and scheduled maintenance concepts. Comparison of alternative construction designs, power generation and distribution systems, water distribution and wastewater treatment systems, industrial processes, and pest control concepts

should be an integral part of the analysis method. The analysis should also identify where pot ..ially hazardous materials are projected to be used, and assess the potential environmental and occupational risks they present.

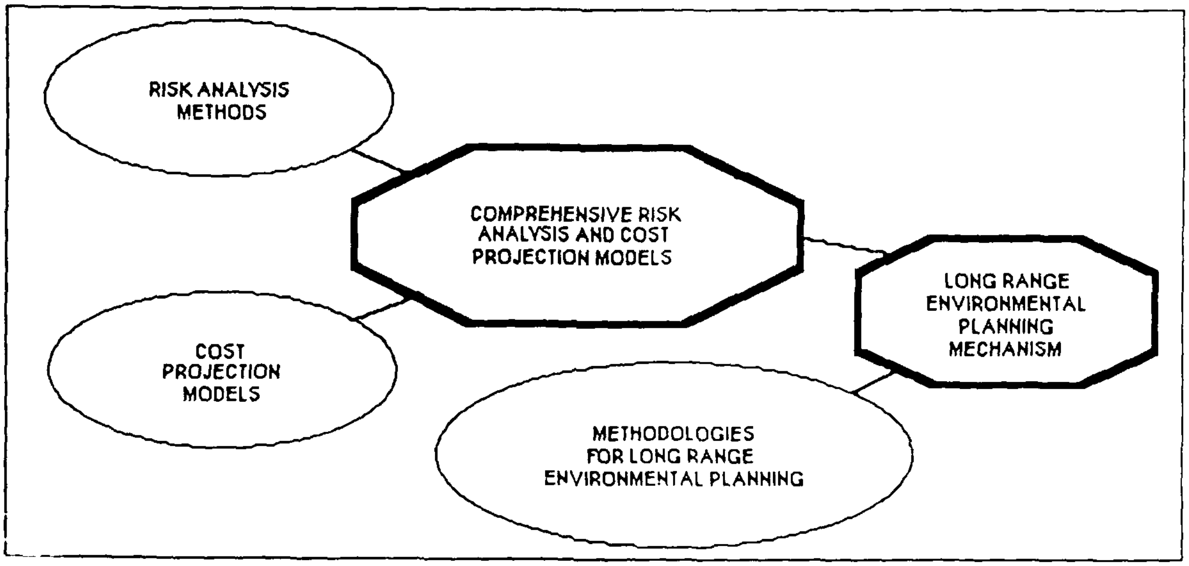

Figure 5

(2) Related Programs:

PE/Proj	Title
63723F	Civil Engineering and Environmental Quality Technology
Proj 2104	Civil Engineering Technology

(3) Assessment:

Timeliness - Near   Criticality: Medium

b. Cost Projection Models

(1) Discussion: The economic impact of the decision to use or not use a particular improvement concept must be quantified in order to affect the decision process. Cost projection models to integrate added costs caused by the use of one material, method, etc., over another are needed. The models should project costs not only of the material handling itself, but also added costs for occupational health monitoring, training, liability, and administrative overhead. These costs, projected over the life of the use of the facility or system, should be integrated into the estimated construction costs of the project.

(2) Related Programs: none.

(3) Assessment:

Timeliness - Near Criticality: Medium

c. Long Range Environmental Planning Methodologies

(1) Discussion: A methodololgy is needed for integrating environmental considerations into long range USAF planning. These plans and policies, supported by technical information from toxicology studies, construction safety, and occupational health sources, will be used to influence future weapons systems, force structure improvements, base and range locating actions, construction plans, and other activities.

(2) Related Programs: none

(3) Assessment:

Timeliness - Midterm Criticality: Medium

IV. CONCLUSION

This special emphasis area planning document has identified a number of human system requirements and some of the enabling technologies which must be pursued to meet these requirements. This is one of the first efforts to capture technology development needs to support the USAF environmental quality and occupational health programs. It should therefore serve as a baseline for requirements as well as a vehicle for stimulating creativity with respect to future requirements planning. Projecting current trends into the future, then planning technology development to meet these future needs provides an opportunity for the USAF to be proactive in addressing environmental quality and occupational health problems, minimizing the need for expensive reactive solutions to these problems later.

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